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APOLLO MONTHLY PROGRESS REPORT (U)

NAS9-150

August 1, 1964

Paragraph 8. 1, Exhibit I

Report Period

June 16 to July 15, 1964

[redacted]

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NORTH AMERICAN AVIATION, INC.

SPACE and INFORMATION SYSTEMS DIVISION

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ILLUSTRATIONS

TABLES

PROGRAM MANAGEMENT

STATUS SUMMARY

The stacking of boilerplate 15 was completed at the Kennedy Space Center (KSC) during the report period. The flight mission sequencer for boilerplate 15 was shipped to Cape Kennedy on June 25. The mechanical mating with the SA-7 launch vehicle was completed on June 26. The installation of the launch escape subsystem (LES) was postponed until the beginning of August because of the possibility of thunderstorms in the area and their possible effect on the pyrotechnics of the LES.

Welding was completed on the forward and aft rings of the forward heat shield of the command module, spacecraft 006, during the report period. Closeout bond operations were completed on the inner crew compartment of the command module, spacecraft 009. The aft bulkhead and side wall assemblies of the command modules for spacecraft 002 and 011 were completed.

The boilerplate 22 service module, after completion of vibration tests, was returned to S&ID from NASA-MSC.

The F-3 test fixture was delivered to the Arnold Engineering Development Center (AEDC). Preparations have been started for the Phase II simulated high-altitude test firings.

The Los Angeles Division of NAA completed the modification of the boilerplate 23 launch escape tower, and manufacturing of the boost protective cover and the canard structure continued on schedule.

Collins Radio delivered a majority of the telecommunications equipment for boilerplate 14 (house spacecraft 1) and all of the telecommunications bench maintenance equipment. Complete sets of brazed heat shields for spacecraft 002, 006, 007, and 009 were delivered from Aeronca. The positive expulsion tanks for the reaction control subsystem of boilerplate 14 were received from Bell Aerosystems.

The Parameter "C" docking simulation study was completed. During the simulation data runs, transposition and lunar orbital docking were studied under a wide variety of control systems variations and innovations. Three NASA astronauts completed a representative run schedule during the final two weeks of the simulation. An interim report is to be completed during the next report period.

SUPPLEMENTAL AGREEMENTS, CONTRACT NAS9-150

A supplemental agreement, referring to the cancellation of one adapter mock-up, was executed by S&ID and NASA and returned to S&ID for distribution. A supplemental agreement was written, incorporating amendments to the documentation requirements. This agreement has been executed by NASA and S&ID and returned to S&ID for distribution.

A supplemental agreement incorporating Master Development Schedule 8 has been rewritten, executed by S&ID, and forwarded to NASA for signature.

A supplemental agreement was received during the report period providing revised contract coverage for five systems trainers, including a propulsion trainer.

ASSOCIATE CONTRACTOR ADMINISTRATION

During the report period, S&ID completed the guidance and navigation laboratory for the use of MIT and their supporting contractors.

The MIT house system, Apollo guidance and navigation equipment (AGE) 4, was delivered to S&ID on June 4. It is currently being used to check out the ground support equipment (see Figure 1).

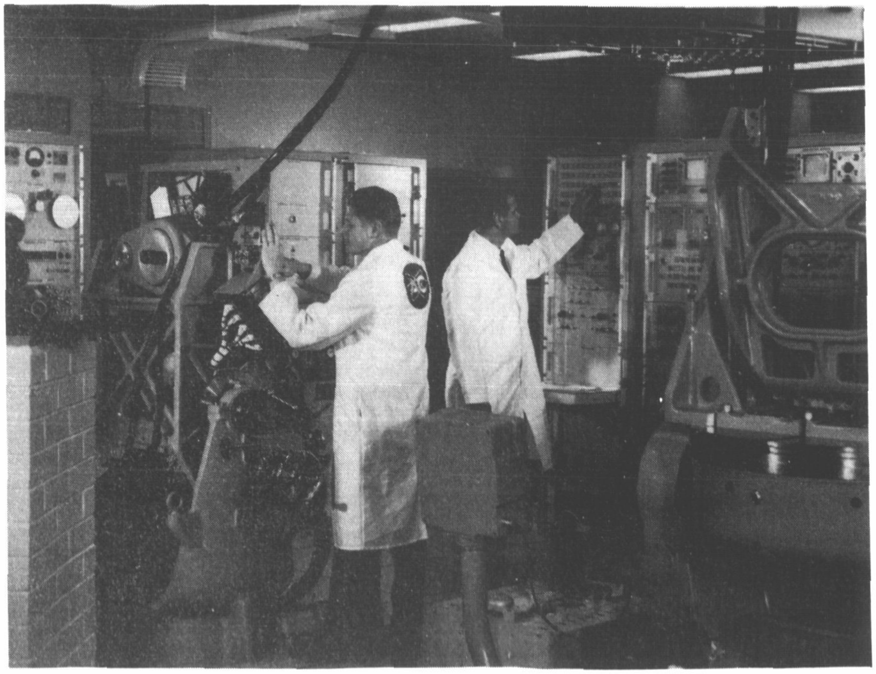

Figure 1. MIT AGE House System at Downey

DEVELOPMENT

AERODYNAMICS

Static force and moment tests of the canard configuration were completed at Ames laboratories in the 8-by-7-foot and 9-by-7-foot wind tunnels. A 0.105-scale model of the combined command module and launch escape subsystem (LES) was used at angles of attack over a 360-degree range for Mach numbers 1.6, 2.0, 2.6, 3.0, and 3.4. Data are being analyzed.

An analysis of the boilerplate 12 post-flight data showed that:

1. The combined command module and LES have greater stability in the transonic range than predicted, and positive aerodynamic damping does occur.

2. The base drag of the command module and LES during LES operation is approximately 25 percent less than predicted from data obtained from scale models in wind tunnel tests.

3. Actual conical surface pressure data obtained during flight verify predicted aerodynamic pressures derived from wind tunnel tests using jet-effects models.

The recommended test point for boilerplate 22 is as follows: Mach number 3.66, aerodynamic pressure 153 psf, and altitude 107,940 feet. The booster configuration required to obtain these test parameters consists of 5 Algol engines fired in a 3-2 sequence with no delay between stages; Little Joe II ballast should be 5000 pounds with a gross stack weight of 151,843 pounds.

MISSION DESIGN

Data were compiled to define critical design missions for subsystems of the Apollo spacecraft. These data will be integrated by the Apollo Mission Planning Task Force with similar information from Grumman on the lunar excursion module to be published in a Phase II Report.

A study was made to determine Block I weight and performance data for a suborbital abort to a 100-nautical-mile earth orbit from a Saturn V boost. Three different combinations of propulsion stages were considered; the earliest time for performing abort to orbit was computed for each. A 78-degree launch azimuth reference trajectory was assumed for each case; the results are shown in Table 1.

Table 1. Suborbital Abort to 100-Nautical-Mile Earth Orbit

Abort Propulsion Stages	Time After Liftoff (sec)	Apollo Weight in Orbit (lb)
S-IVB + service module	154.404*	23,400
S-IVB	410.0	90,000
Service module	492.0	23,000
*Nominal S-II ignition is assumed.		

Operational ground rules and steering laws for these abort modes have not yet been established. These data are based on (1) a 20-second coast between booster shutdown and abort propulsion ignition to simulate decision-making and separation time, and (2) thrust attitude controlled to maximize weight in 100-nautical-mile orbit.

The orbital decay history of the boilerplate 13 flight was simulated using a precision digital trajectory program. Assuming an atmosphere as defined by the Air Research and Development Command in 1959 and a ballistic parameter value W/C_DA** = 37.0, a lifetime of 79.05 hours after insertion into earth orbit was computed. The actual flight entry time occurred 16.8 minutes later than that computed, and the actual entry occurred east of Canton Island—about 4200 nautical miles further down-range than the computed entry. These errors in time and range appear reasonable and justify an extrapolation of W/C_DA to 37.13. This value would correspond to an effective average angle of attack of 21.5 degrees during tumbling of the spacecraft. The computed regression of the node, 8.11 degrees per day, appears to agree with theory and with the altitude decay time history plot. Detailed analysis will be included in the post-flight report.

** $\dfrac{\text{vehicle weight}}{\text{drag coefficient x area in square feet}}$

CREW SYSTEMS

The transposition-docking phase of the docking simulation study at NAA-Columbus was completed; results are being analyzed. Approximately 169 runs were made to obtain data in the following areas:

1. Effect of unpressurized garment, helmet, and gloves on crew performance
2. Reaction control subsystem (RCS) jet logic comparisons
3. Command and service module optical alignment subsystems
4. Two- and three-dimensional targets
5. Initial relative vehicle displacement effects
6. Single-axis attitude disengagement
7. Control subsystem failures
8. RCS quadrant failures
9. S-IVB attitude drift

Computer remechanization and modifications of the simulation complex were completed for the lunar orbital docking phase, and a series of data runs was completed; results are being analyzed.

The 14-day lunar mission flight crew performance specifications (SID 62-90, Volumes I, IIA, IIB, and III) were published. These documents consist of a general specification of the Apollo spacecraft man-machine interface (Volume I), a timeline of crew activities during a representative lunar landing mission (Volume IIA and IIB), and a detailed specification of spacecraft operations based on current systems design (Volume III).

Impact test 71 of the landing impact and stability test program was accomplished on June 8 using boilerplate 2. This test used, for the first time, a self-contained instrumentation package installed in a dummy stationed in the center couch. Triaxial accelerometers in the dummy's head and chest were used for measuring impact loads. Rate gyros determined the motion of the dummy's head, and strain gauges measured loads imparted to the restraint harness. Onboard cameras documented the general motions and responses made by the dummy during impact. Two other dummies used in the test were not instrumented.

Figures 2 and 3 show, respectively, the positions of the anthropomorphic dummies and couch attenuation struts before and after impact.

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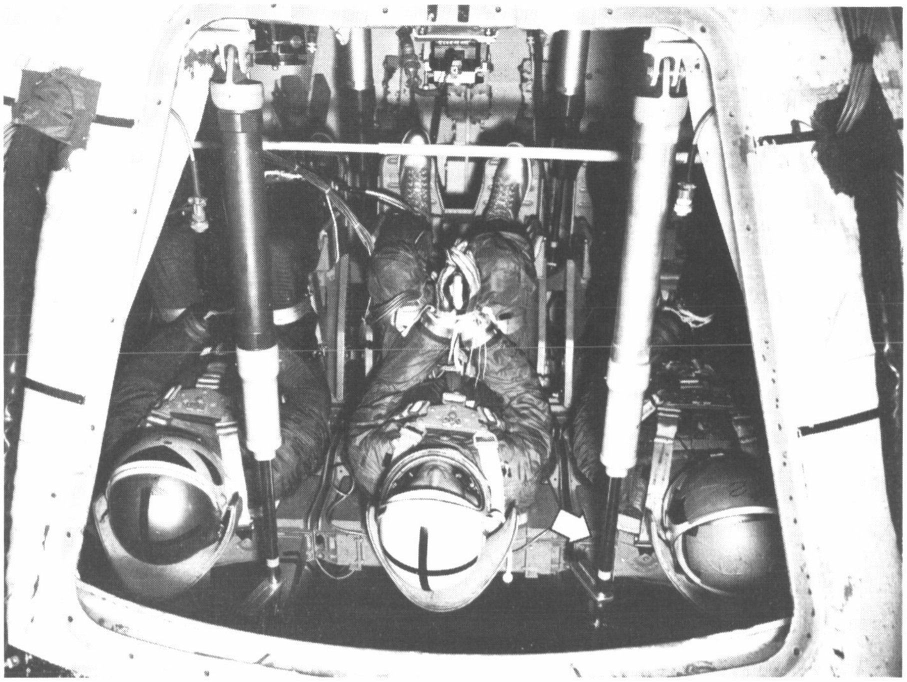

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Figure 2. Position of Anthropomorphic Dummies and Couch Attenuation Struts Before Impact

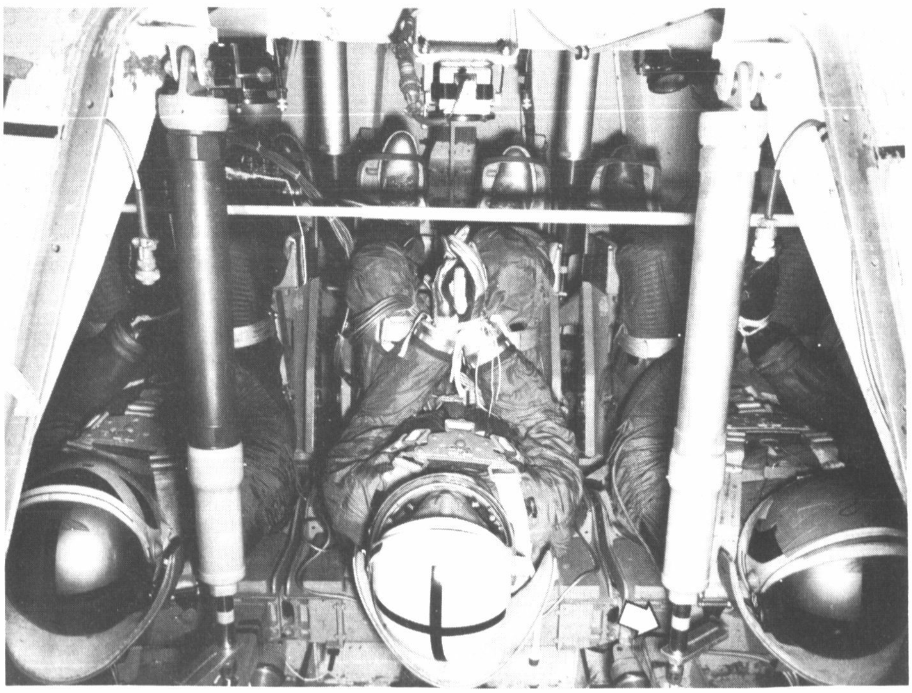

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Figure 3. Position of Anthropomorphic Dummies and Couch Attenuation Struts After Impact

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Numerous small black patches are used to show the position of straps relative to the dummy. The second photograph reveals that no motion of the dummies occurred in either the couches or restraint harnesses, indicating that the subsystem affords excellent support and restraint. The 10-inch stroke of the struts may be observed by comparing the pictures before and after impact.

STRUCTURAL DYNAMICS

A flotation analysis was made to predict the maximum pitching excursions of the command module in both the upright and the overturned stable conditions. These excursions were determined to be 67 degrees for the upright position and 44 degrees for the overturned position, for exposure of less than 1 hour to sea-states 3 and 4 (waves approximately 6 to 10 feet high). Under these conditions, water will reach the side hatch when the command module is in the overturned attitude. However, an uprighting bag is being designed to assure flotation of the command module in the vertical position.

Tenth-scale-model flotation tests were conducted to determine pitching frequencies for both stable flotation positions. The results showed that all periods would be between 2.1 and 3.8 seconds for the full-scale vehicle. The longer periods were coincident with those found for waves of sea-state 3 because the natural frequency of the vehicle is approximately in phase with the sea wave frequency. However, the higher energy waves of sea-state 4 are frequently opposed by the natural frequency of the vehicle. Thus, vehicle responses under both sea-states 3 and 4 are approximately the same.

A review of the requirements and objectives of modal, acoustic, and environmental vibration tests on full-scale spacecraft modules was conducted with NASA on June 30 and July 1 at Downey. It was recommended that modal tests should have first priority, followed by acoustic tests and then environmental vibration investigations, for the following reasons:

1. Data obtained from studies of natural modes and frequencies become fundamental tools in studies of stability and control and of dynamic loads.

2. Confirmation of theoretical work by experiment is mandatory.

3. Acoustic tests provide the most reasonable way of evaluating those predicted vibration levels in various zones of the spacecraft that were based on buffet and boundary layer noise excitation.

4. Since individual components and subsystems will be vibration-tested, the need for a complete spacecraft vibration test becomes of secondary importance.

STRUCTURES

Delivery was made by Aeronca of complete sets of the brazed heat shield panels (stainless steel honeycomb) for spacecraft 002, 006, 007, and 009. Partial delivery was made for spacecraft 008 and 011. These panels are being fit-checked, and additional hardware is being installed. The panels for spacecraft 006 will be shipped by S&ID to Avco in late July for installation of the ablator material.

Nine gas gun shots were fired at service module targets by the Defense Research Laboratory of General Motors in the meteoroid impact test program. The gas guns simulate meteoroid impacts by firing steel balls, each weighing 0. 05 grams at velocities of 22, 000 to 26, 000 feet per second, at half-inch thick stainless steel honeycomb sandwiches. Results of these shots will be used as a reference base to compare the effects of higher velocity shaped-charge impacts in tests to follow.

Wetability tests of various brazing alloys were completed on 17-7PH. The tests showed Premabraze 128 to be successful for this purpose; as a result, all brazing of 17-7PH spacecraft plumbing joints will be done with this alloy.

A study and test program is under way to determine the configuration of the command module-to-lunar excursion module interface docking seal. Low-temperature modulus data are being evaluated to determine whether a solid silicone seal between the modules can be closed at -150 F. If the load required exceeds the available locking force, a hollow 0-ring seal configuration will be considered.

FLIGHT CONTROL SUBSYSTEM

Stabilization and Control (SCS)

Problems encountered in the checkout of the control amplifier test set for the RCS were identified; they are being corrected by breadboard modification. The SCS model specification (SID 64-677) was published in preliminary form. Rough functional drawings showing a proposed SCS configuration for Block II were submitted to NASA.

Electronic Interfaces

The strength of the Hughes Aircraft Company special-purpose electric connector was greatly improved by the use of a new diallyl phthalate material, Rogers 1360T, in the body of the connector. Residual gases were removed by heating, and the material successfully passed outgassing requirements. Strength tests conducted by Hughes indicate that this material is one-third stronger than the plastic material previously used.

Flight Subsystems Analysis

The simulation study of the manual thrust vector control (TVC), requested by NASA, was conducted using the hybrid simulator at Honeywell. Five astronauts, two pilots, and two engineers "flew" the simulator. The main purpose of the study was to evaluate the capability of the crew to perform manual TVC for the transearth injection maneuver by direct manual control of the gimbal deflection of the service propulsion subsystem engine without use of body rate feedback. A star field, as viewed from the docking window, and the flight director attitude indicator were used for attitude reference. Although many successful runs were made using the manual mode of control without body rate feedback, a significant number of cases resulted in loss of control. Quick-look results appear to substantiate conclusions obtained from a previous study indicating that the manual control method with body rate feedback is more reliable.

Automated Control

Model specifications were completed for the automated control system for spacecraft 009. Procurement specifications for the attitude reference system and the control programmer were revised and released for this spacecraft.

TELECOMMUNICATIONS

Communications

85 percent of the airborne communications equipment required for boilerplate 14 was acceptance-tested and delivered to S&ID. With the exception of the flight qualification recorder, due in mid-January, the balance of the equipment is expected by mid-August, 1964. Figure 4 shows the configuration of most of this equipment.

Proposed changes in the recovery antenna equipment on Block I spacecraft, as requested at the mock-up review of Block I in April, were reviewed with NASA during this report period. The recommended changes were as follows:

[redacted]   [redacted]

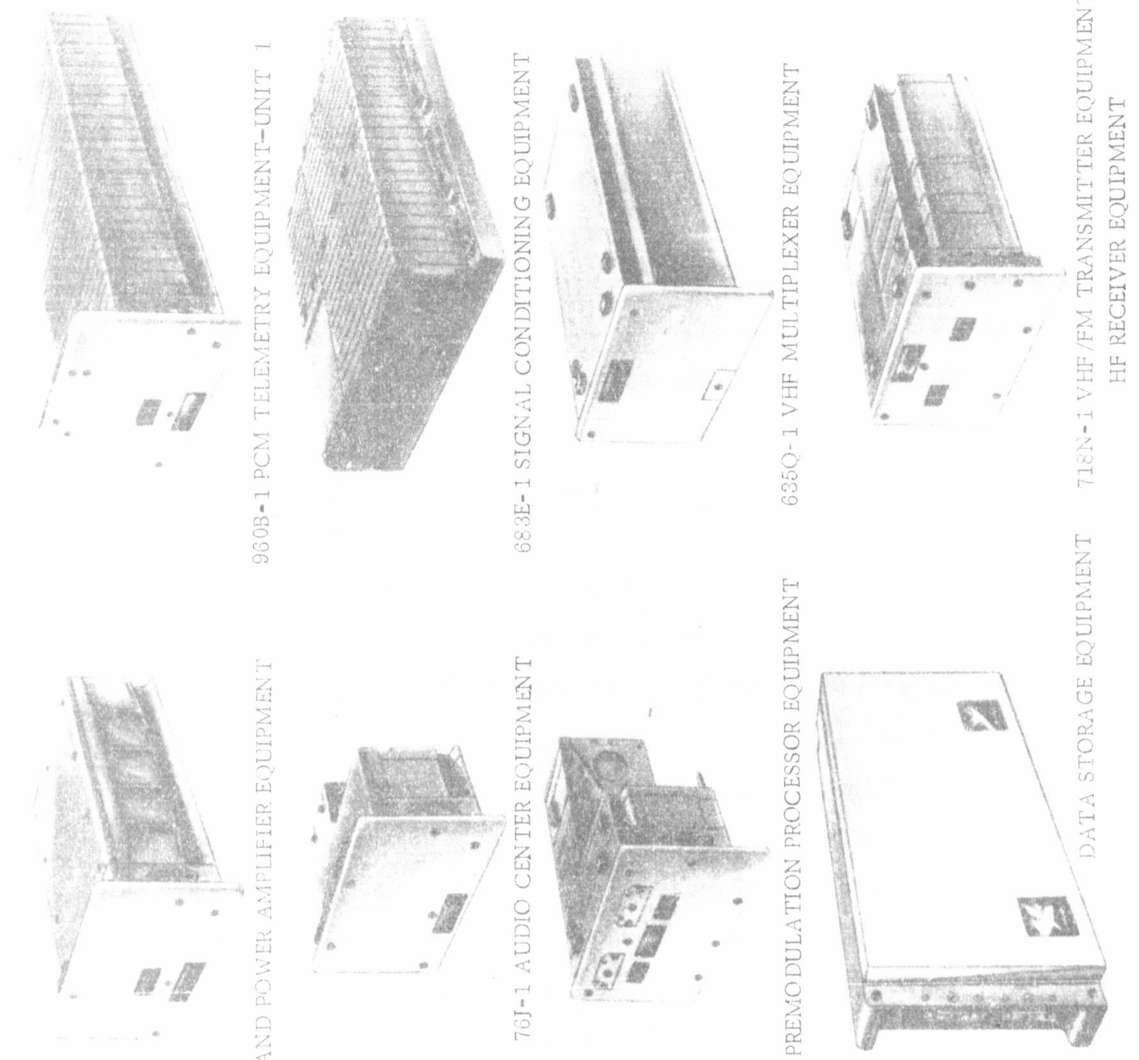

Figure 4. Apollo Communications and Data Equipment

[redacted]

1. Use of the Apollo recovery antenna as an HF antenna only

2. Use of two of the Gemini-type VHF antennas, one for the recovery beacon and one for the VHF/AM transceiver

NASA was to investigate the procurement of the Gemini antennas as Government-furnished equipment (GFE) or Contractor-furnished equipment (CFE) and to determine the method of qualification of these antennas for Apollo requirements. Resolution of these recommendations is expected following the July mock-up review of Block I vehicles.

Acceptance tests were performed at the Motorola facility on the S-band equipment for the spacecraft-GOSS interface test system (SGITS). Receiver performance measurements, such as bandwidth, sensitivity, image rejection, and oscillator stabilities were included in the tests. Functional tests were also performed on the ranging subsystem, and measurement was made of the stability, power output, and spurious content of the S-band test transmitter. The SGITS equipment met all of the design specifications and greatly exceeded many performance requirements.

Detailed analysis of the communication subsystem requirements for Block II spacecraft was begun to determine required functional changes and possible functional redundancy. Alternate equipment configurations that conform to the requirements of several proposed arrangements for spacecraft electronic equipment were reviewed. Investigation of a method to provide simultaneous stored and real-time pulse code modulation was begun, comparing the use of a separate S-band FM transmitter versus a third subcarrier on the existing unified S-band transmitter.

Instrumentation

The instrumentation subsystem model specification (SID 64-687) describing the Block I configuration was published. The operational measurement requirements list for Block I is in process of review to delete all in-flight test system measurements as well as any others not essential to the mission. A reduction of over 100 measurements per vehicle is anticipated. Spacecraft 008 environmental test measurement requirements, exclusive of operational requirements, were reduced from 1763 to 780.

The first delivery of nonstandard sensors was received at S&ID. This marks a significant milestone because of the long lead time required for these items.

[redacted] [redacted]

ENVIRONMENT CONTROL

Radiator panels for the environmental control subsystem (ECS) of spacecraft 006 successfully passed helium leak checks and proof pressure tests. They were then bonded into the service module structure.

Additional analysis of potential ECS corrosion areas was made. AiResearch, the ECS subcontractor, has manufactured components from approximately 26 dissimilar materials without encountering serious corrosion problems. A circulating system using a water-glycol solution containing a corrosion inhibitor has now operated three months without evidence of corrosion. Tests by AiResearch show that aluminum corrodes 160 times faster without the inhibitor.

AiResearch completed delivery of the ECS unit for boilerplate 14 to S&ID during this report period. Prototype GSE was received for the low-pressure gaseous test stand, the liquid test stand, and the stimuli generator test set.

Water management, the pressurization of the lunar excursion module, and the waste management subsystem were the subjects of an interface discussion with Grumman. It was concluded that there will be no waste management interfaces, because water cannot be transferred to the lunar excursion module without redesign of the lunar excursion module and the command module subsystems. The concept of pressurizing the lunar excursion module from the command module must be revised, including an increase in the quantity of oxygen required and the pressure with which it is supplied.

The temperature history of the command module air during prelaunch conditions was determined to liftoff, including a 5-hour hold after button-up of the hatch. A minimum temperature of 55 F is achieved, with the command module air conditioning cart supplying 40 pounds per minute of 50 F air to the cabin before closing of the hatch. A maximum cabin air temperature of 67 F is reached 3 hours after the hatch has been closed and at the end of 6 hours' exposure of the command module to the direct rays of the sun.

The RCS jet interaction heat transfer for a roll engine of the service module was evaluated during a representative space maneuver for design reference. The surface heat load surrounding the roll engine increases from 400 to 1400 Btu per square foot during a total burning time of 100.26 seconds.

[redacted]

Thermal analyses of recent test data show that a low-density Q-felt (4 pounds per cubic foot) may be used as thermal protection material for the service module aft bulkhead and aft bulkhead heat shield instead of the present Q-felt weighing 6 pounds per cubic foot.

A thermal analysis was made to determine temperatures for the command module heat shield with various roll rates and ablator thicknesses. Cyclic steady-state temperatures for the ablator surface with and without temperature control coating (TCC) are shown in Table 2.

Table 2. Cyclic Steady-State Temperatures

	Command Module Roll Rates					
	0.2 rev/hr		0.5 rev/hr		1 rev/hr	
Ablator Material	Max Temp (F)	Min Temp (F)	Max Temp (F)	Min Temp (F)	Max Temp (F)	Min Temp (F)
0.2-in. ablator without TCC	214	-169	178	-97	129	-36
0.2-in. ablator with TCC	53	-190	10	-124	-20	-91
0.8-in. ablator without TCC	164	-77	135	-26	122	-4
0.8-in. ablator with TCC	4	-117	-16	-90	-23	-79

ELECTRICAL POWER SUBSYSTEM (EPS)

Qualification testing of the titanium hydrogen pressure vessels was completed with a successful burst at 771 psi under ambient test conditions. This is the first such tank to be fully qualified for use in the Apollo program. The first oxygen Inconel 718 pressure vessel was successfully burst at 2233 psi at -320 F using liquid nitrogen as the test fluid. The maximum operating pressure of this vessel is 1020 psi; the calculated burst pressure is 1530 psi at room temperature. The high burst pressure resulted from the extremely low test temperature.

The heat-leak reduction program at Beech was completed, with leak rates for both oxygen and hydrogen storage tanks meeting all design requirements for the Apollo spacecraft mission. The heat leak at an ambient temperature of 130 F was 23 Btu per hour for the oxygen tank and 7.8 Btu per hour for the hydrogen tank.

The fuel cell operating temperature has been lowered approximately 25 F in the condenser exit. This somewhat limits the heat rejection capability in a high heat environment, but the increase in fuel cell life resulting from the temperature decrease more than compensates for the rejection loss.

Modification and development testing was completed on the verification unit of the Westinghouse inverter. A reduction of electromagnetic interference (EMI) to acceptable levels for prototype inverters was accomplished by adding filters on the input side.

Power to the sequencer in boilerplate 22 and spacecraft 002 and 010 will be derived from two new NASA-furnished Eagle-Picher 4090 batteries that together furnish 37.2 volts. This arrangement will provide voltage characteristics which are more compatible with the sequencer design. Originally, these sequencers were powered by the entry batteries, which provided only 33.7 volts.

An analysis was made of hydrogen utilization for a proposed Block II system, using three hydrogen and three oxygen cryogenic storage vessels located in the same service module bay with three fuel cells. The size and thermal resistance of the vessels were the same as the present configurations. Because of the proximity of the fuel cells, a local service module temperature of 180 F was assumed for the two aft hydrogen tanks and 225 F for the upper tank. With this high thermal environment, equal depletions of the tanks will result in larger fluid venting losses by mid-mission. An arrangement analyzed to minimize these venting losses uses the maximum flow rate from the upper tank until it passes the point of minimum specific heat input. Thereafter, hydrogen is withdrawn from the two aft tanks as rapidly as possible, and only the flow rate required to prevent overpressurization is withdrawn from the upper tank. Venting is therefore not required, and heat leakage alone provides the necessary hydrogen flow rate to operate the fuel cells at a minimum of 2210 watts for 216 consecutive hours in the middle of a 336-hour mission. Heating is required, however, at the beginning and at the end of the mission.

PROPULSION SUBSYSTEM

Service Propulsion Subsystem (SPS)

The F-3 test fixture was delivered to AEDC on June 24, and preparations for Phase II high-altitude engine firings were begun. Actual testing will follow completion of a USAF test program in progress in the J-3 test cell.

Mock-ups of the SPS plumbing on boilerplate 14 and spacecraft 001 were completed, and sample lines were fabricated. Some design verification test type components are being used on these vehicles. Such components include the pressure regulators, check valves, helium isolation valves, propellant flex connectors, and heat exchangers.

100 firings were accomplished on the SPS engine development program at Aerojet-General. The five-baffle injector was selected as the primary design in the dynamic stability program; it will be used in the qualification test program. Fabrication of six-baffle injectors was discontinued. Table 3 lists all firings conducted during this report period.

Reaction Control Subsystem (RCS)

Nitrogen tetroxide and unsymmetrical dimethylhydrazine were loaded into the Phase II breadboard propellant tanks of the service module RCS to mark the first exposure of the subsystem to propellants. The downward-directed (positive pitch) engine was successfully hot-fired for one 7.3-second steady-state run followed by 10 cycles of 0.050 seconds on and 0.050 seconds off, and 38 cycles of 0.013 seconds on and 0.010 second off. A preliminary review of the data obtained shows satisfactory subsystem performance.

Recent test results at Rocketdyne show that the command module RCS engine performance may be higher than previous testing had indicated. Testing to verify this higher performance level is in progress.

Design parameters for a service module RCS engine with two-stage ignition are being developed at Marquardt. Spikes were eliminated in tests with a workhorse engine, indicating that a practical design is attainable.

Launch Escape Subsystem (LES)

The LES qualification programs are each being reduced by 6 motors to 20 LES motors, 22 pitch control motors, and 20 tower jettison motors. The first two LES motors to be qualification-tested were successfully static-fired on June 19 and July 1.

The effect of new lots of ammonium perchlorate and iron oxide on the burning rate of LES motors is being studied in 10-percent and 150-pound batches. Casting of LES motors is being held pending results from these tests.

The first developmental firing of a tower jettison motor with a 3.8-degree thrust vector angle was successfully completed. The motor

[redacted]

Table 3. Apollo SPS Engine Test Program

Serial No.	Pattern Type	Type of Evaluation	Ablative Chamber		Steel Chamber		Remarks
			No. of Firings	Time (sec)	No. of Firings	Time (sec)	
0006 (5-4-4)	POUL-41-24	Compatibility	2	92.0			Severe streaking. Pattern to be modified.
0003 (5-4-4)	POUL-41-25	Balance			1	5.0	Satisfactory
		Pulse			2	10.0	Satisfactory recovery from 156.9 grain pulse
		C*			3	16.0	C* = 95.9%. Injector to be modified.
0011 (5-4-4)	POUL-41-23	Balance			1	5.0	Satisfactory
		Pulse			2	13.0	Satisfactory recovery from 156.9 grain pulse
		C*			5	26.0	Low performance
AFF-33	POUL-31-37	Acceptance			5	27.0	Satisfactory. Scheduled for engine assembly serial number 011 (AEDC).
AFF-30	POUL-31-37	Acceptance			5	28.0	Satisfactory. Scheduled for engine assembly serial number 017.
AFF-52	POUL-31-10	Acceptance	1	30.5	5	27.0	Satisfactory. Scheduled for engine assembly serial number 010.
AFF-75	POUL-31-10	Acceptance	1	31.0	5	28.0	Braze joint crack. Rejected. Backup was AFF-52.
BF-18	POUL-41-8	Pattern performance			3	17.0	Satisfactory
		Pulse			2	11.0	Charge did not ignite during first firing.
AFF-27	POUL-31-37	600-cps investigation	57	1388.0			One CSM shutdown

C* = characteristic velocity

[redacted]

[redacted]

was fired in a 70 F environment with a burn time of 1.093 seconds. A maximum thrust of 34,697 pounds and a total impulse of 36,614 pound-seconds were recorded. Preliminary results indicate that performance met predicted values.

Propulsion Analysis

A study of methods for preventing possible interplay between parallel regulators within the SPS pressurization system was completed. Use of only one side of the parallel pressurization system at a time best satisfied all requirements. The parallel counterpart is held inactive by maintaining the helium solenoid valve for that side in a closed position until needed.

A total of 32 drop tests was made to complete the study of propellant motion in SPS tanks under zero-g flight conditions. Preliminary results confirm previous analyses. Because of propellant motion at SPS shutdown, the propellant is expected to reach the top of the tank during coast. Analysis is continuing to determine the conditions under which the tank outlet is uncovered because of propellant motion and to establish a realistic model of propellant motion during zero-g conditions.

DOCKING AND EARTH LANDING

The main parachute configuration resulting from the current improvement program is the equivalent in area of a parachute 83.4 feet in diameter. The weight saving and improvement in performance have been gained at the expense of an increase of 3.5 fps in rate of descent at sea-level.

A reefed drogue test was conducted to obtain performance data on two drogue chutes with 6-second, 40 percent active reefing and 57 percent permanent reefing. Preliminary analysis indicates that this configuration gives satisfactory results and will become the accepted design.

A "pancake" water drop of boilerplate 2 was made from a height of 202 inches and a weight of 8892 pounds. Each couch attenuation strut stroked approximately 10 inches, exceeding predictions of a 4-inch stroke; the aft heat shield was cracked. This drop simulated conditions anticipated for a two-parachute earth landing. Further analyses of the test data are in progress.

[redacted]

GROUND SUPPORT EQUIPMENT (GSE)

Acceptance Checkout Equipment (ACE-SC)

ACE-SC equipment is being expedited in support of boilerplate 14. Alternate sources were selected for the miniaturized logic modules used in the adapter for the ACE-SC servicing equipment. Analysis of the digital test command system (DTCS) indicates that this equipment is adequate to provide stimuli to meet all present requirements. The DTCS building block design will facilitate any necessary changes of stimuli quantities by adding or subtracting baseplates and modules without the necessity of a DTCS design change.

GSE Cable Subsystems

A mock-up of ACE-SC carry-on equipment was installed in a command module. It revealed that the individual cable construction of the carry-on equipment was bulky, restricting access to ACE-SC and spacecraft modules. A harness arrangement with no outer sheath should alleviate this condition.

Acceptance tests of the bench maintenance equipment (BME) used to check out and verify performance of the Apollo onboard television subsystem were completed; the first unit is being prepared for shipment to Downey. Testing is in progress on a second unit for Downey and for units to be delivered to MSC and KSC (see Figure 5).

Servicing and Checkout GSE

Engineering on the nozzle adapter for the RCS fluid disposal unit was completed, and the item is being fabricated. The first unit (required in support of spacecraft 001) consists of 16 adapters, 1 pressurization unit, 1 flexible hose, and a carrying case. This unit will be used as a drain or plug in the service module RCS and the service propulsion subsystem (SPS) engine in conjunction with the flow sensor set for the checkout of engine inlet valves.

Engineering was completed on the gaseous helium pressure test unit; fabrication will begin during the next report period on the first unit required to support spacecraft 001. This model will be used to perform pressure and leak checks on the cryogenic tanks in the test preparation area at the propulsion system development facility (PSDF). The pressure test unit consists of a caster-mounted console containing pressure gauges, relief valves, and manual valves. The unit consists of two duplicate subsystems for checkout of the cryogenic tanks, one for the liquid oxygen tank and one for the liquid hydrogen tank. 50-foot hoses that interface with the spacecraft disconnects are stored within the console.

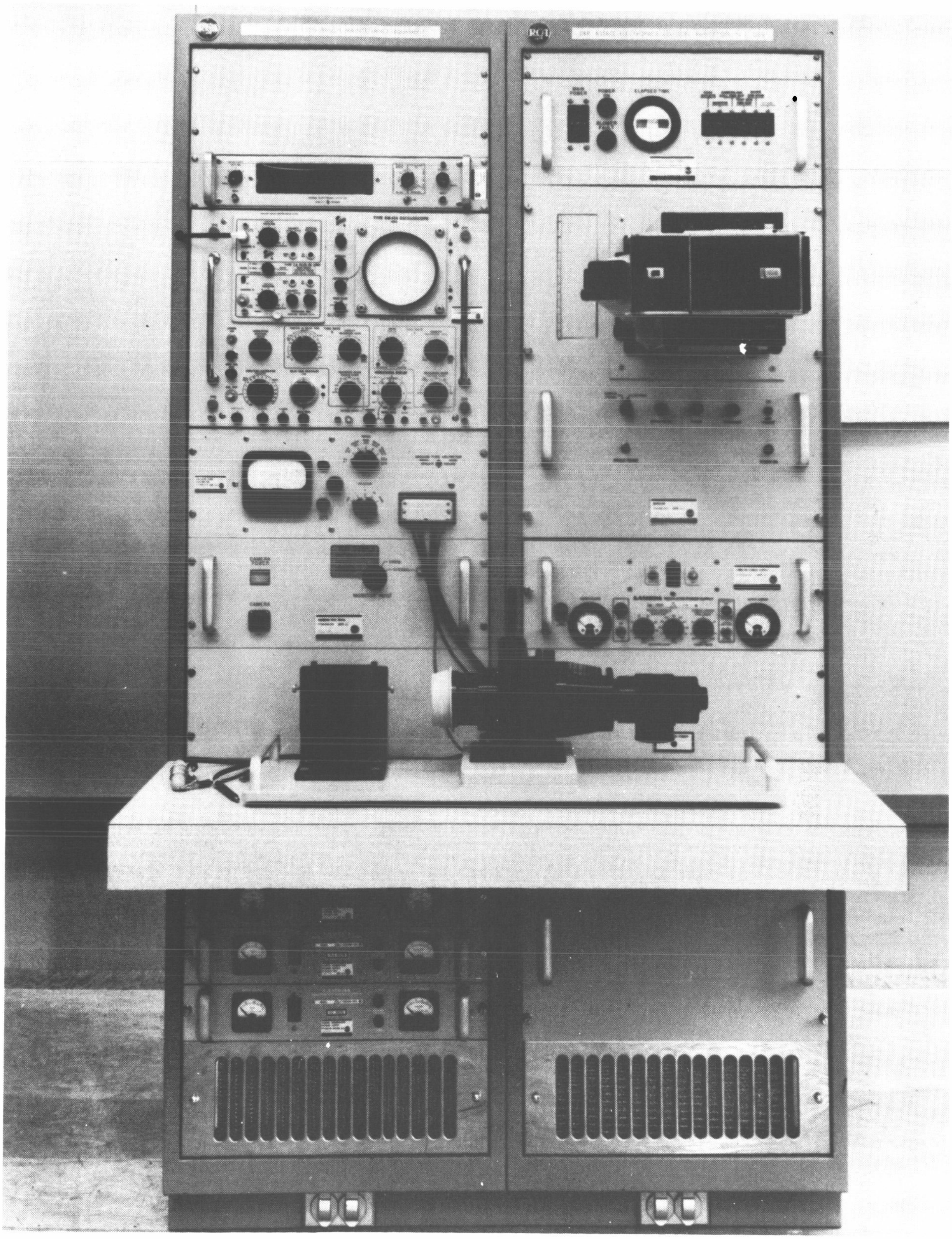

Figure 5. Television Subsystem Bench Maintenance Equipment

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The high purity requirements of the spacecraft electrical power subsystem (99.94 percent for hydrogen and 99.99 percent for oxygen) necessitate the addition of a purity monitoring subsystem to monitor continuously the flow of liquid hydrogen and oxygen to the cryogenic tanks to detect the presence of carbon dioxide or water.

<u>Handling GSE</u>

The design of the weight and balance set for the command module was revised by replacing the yoke with lifting lugs and a rigid spreader bar, allowing a more even distribution of loads into the command module-LES tower attach points. A box level and mounting bracket were added to provide for an alignment check of the weight and balance fixture.

The shortage of load cells, hindering weight and balance operations at Downey and WSMR, will be alleviated by the release of a modification kit incorporating load cells and accessories into the digital indicator. All available models will then be placed in service at Kennedy Space Center (KSC) and White Sands Missile Range (WSMR), and the electronic weighing kits will be removed from these facilities and returned for use at Downey.

SIMULATION AND TRAINERS

The docking complex for the simulation study recently completed at NAA-Columbus consisted of a command module mock-up, interface equipment, prototype equipment, visual displays, a rig with six degrees of freedom, and four sections of analog computer equipment. The latest Honeywell prototype controllers and the flight director attitude indicator were a significant source of simulation data. The visual display subsystem included an Eidophor TV projector, which produced a visual image twice as clear and 16 times brighter than any previously used in simulation studies. The visual display subsystem made successful simulated night docking possible with three orientation lights on the lunar excursion module.

Preliminary analysis of the data obtained from the first phase of the docking study indicates that docking can be accomplished with the S-IVB configuration tumbling at rates of 0.25 degrees per second. In addition, it was tentatively established that discrete level rotational command control is feasible during the lunar orbital docking phase.

PROJECT INTEGRATION

A detailed study was made of the effects of operating spacecraft electronics in the presence of free moisture. The results showed that this

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equipment must be moisture-protected. Moisture protection will be provided by the use of potting, foaming, and conforming coatings.

VEHICLE TESTING

Boilerplate 12

The flight report for boilerplate 12 was published on July 14. Various components are being tested and analyzed in an effort to duplicate their in-flight behavior in the laboratory. The parachutes will be repacked and used for nonflight installations, such as design engineering inspection (DEI) displays.

Boilerplate 15

All modules of boilerplate 15 were shipped to KSC during June. The command module, the service module, and the adapter insert were stacked in the hangar; they were then transported to the pad, where they were mated to the launch vehicle on June 26. The RCS engine and the instrumentation modification kit were installed at the pad. The vehicle instrumentation subsystem was checked out, grain inspection and pressure check of the LES motor were satisfactorily completed, and the buildup of the LES was begun.

Boilerplate 23

The mission for boilerplate 23 was reviewed, the test plan and other engineering requirement documents were released, and a schedule for completion of all constraint tests was established. The LES tower is receiving a protective coating of Buna-N ablative material, and the electrical wire harness is being installed.

Spacecraft 001

The delivery, installation, and brazing of EPS tubing and cryogenic tubing are currently pacing the vehicle completion, with tube installation and brazing approximately 70 percent complete. Fabrication and installation of wiring harnesses is approximately 80 percent complete Vehicle checkout and delivery can be affected by the availability of GSE. The first firing at PSDF is contingent upon delivery of GSE and installation of the facility fluid distribution system. Overlapping manufacturing schedules, work-around methods, and alternate sequences are being studied to prevent schedule slippages in these areas.

Spacecraft 006

The design configuration for spacecraft 006 was frozen in order to complete manufacturing. Further changes will be incorporated by retrofit or modifications after completion of manufacturing.

RELIABILITY

Block I and II qualification test requirements are being defined. Block I mission definitions were completed; Block I hardware critical needs are being determined and related to potential reductions in the number of articles for tests during 1965. Environmental test criteria and general test requirements were also defined.

A study was conducted of alternate radar antenna locations. Station 268 (68 inches forward of the service module and adapter interface) appears to be the most desirable location from the viewpoint of reliability alone. When all factors are considered however—aerodynamic stability, over-all thermal environment, and boost and injected weight—station 196 (4 inches aft of the service module and adapter interface) appears to be the best compromise location; a deployable boom is required at this location.

Results of a Block II redundancy study of PCM telemetry equipment indicated that this equipment should be operationally redundant at the module group level. Although redundancy would result in a negligible difference in reliability, a great weight saving would be realized, because the redundant telemetry equipment can be packaged in a manner that would reduce wiring weight.

Reevaluation of the over-all control programmer subsystem resulted in the deletion of dual redundancy requirements for the automatic command control and sequential timer portions. With minor changes in the radio command control function of the subsystem, the redundancy requirements for the spacecraft 009 mission can be met, so that no single failure in the control programmer will cause loss of spacecraft. The deletion of dual redundancy will not jeopardize the attainment of the control programmer reliability objectives.

An analysis was performed on the SCS control panel to determine the capability of mode switching functions for a three-day earth-orbital mission. The study indicated that no single failure mode existed to prevent recovery of the spacecraft and that the design would meet mission reliability requirements.

OPERATIONS

DOWNEY

Boilerplate 23

Modification was completed on boilerplate 12 GSE to support operations with boilerplate 23; modification kits were installed in the applicable items of GSE. Replacement and hookup of the modified GSE in the tower area was completed, and checkout was performed.

Boilerplate 16

Direction was received from NASA to delete the integrated checkout phase for boilerplate 16 at Downey. This redirection also deletes the requirements for modification and checkout of the supporting GSE. The test effort expended has been to accomplish the weight and balance checks on boilerplate 16. Action is in process to modify the test plans upon receipt of contractual direction. Shipment of boilerplates 16 and 26 is expected on or before August 17.

General

Two methods of installing the structural skirt on an inert launch escape motor were demonstrated. One method was an installation from the rear using the launch escape subsystem (LES) shipping containers; the second method was a forward-end installation using existing GSE. This demonstration resulted in the recommendation that the field sites employ the aft installation method with the launch escape motor in the shipping container. This method will save time and maintain a higher degree of safety and quality control.

During the next report period boilerplate 23 will be updated as necessary. Individual systems checkout will be started.

Stacking and alignment of the LES will be accomplished on boilerplates 16 and 26, and the vehicles will be prepared for shipment to the Florida facility. No integrated system tests will be performed on these vehicles.

ATO house spacecraft personnel will work with manufacturing and engineering to complete the original system installations and changes so that electrical power system testing can begin on boilerplate 14.

WHITE SANDS MISSILE RANGE

Propulsion System Development Facility (PSDF)

Validation of the PSDF closed-circuit television system was performed. The cable installation for the interim fire-control console was completed, and the servo speed control subsystem of the data acquisition system was checked out satisfactorily with the three analog tape recorders.

Cleaning of components for the fluid distribution system prior to installation was delayed by equipment failure in the WSMR cleaning laboratory. This failure precluded cleaning of components for the F-2 engine and delayed engine installation in the test fixture. Fabrication of the winch and cable set, required for installation of the test fixture F-2 engine, was completed.

Components of the engine vibration safety cutoff system were installed in the control center. The cathode ray oscilloscope test and the pulse code modulation bit packing test were conducted with the data acquisition system.

Modification of the interim fire-control panel was completed by the addition of fuel and oxidizer purge switches. The cable validation unit was completed, and the fire-control panel with associated cabling was checked out satisfactorily.

The PSDF cleaning laboratory began operations on July 8; because of the backlog of parts requiring cleaning, it was immediately overloaded. Cleaning of parts is being accomplished as rapidly as possible.

During the next report period, the test fixture F-2 heat exchanger modification will be installed. Leak checks and functional checks of the test fixture will be performed, followed by installation of the F-2 engine. An engine leak check and functional check will then be accomplished.

Rework of the fuel and oxidizer toxic vapor disposal units will be performed, and both units will be validated for use.

The fluid distribution system modifications will be completed, and the system will be validated.

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Mission Abort

Modification of on-site GSE to support boilerplate 23 and modification of the launch complex to make it compatible with the GSE changes will continue in preparation for boilerplate 23 field operations.

FLORIDA FACILITY

The arrival of the command module, LES, and remaining GSE on June 15 completed the delivery of boilerplate 15 and supporting GSE to the Florida facility. Checkout operations in Hangar AF were completed with stacking of the command and service module combination on the adapter on June 24. The command and service modules were mechanically mated to the launch vehicle on June 26. Modification of the service module was completed on July 1 with the installation of the instrumented reaction control subsystem engine quad "A" as shown in Figure 6.

The "D" model environmental control subsystem (ECS) pump was installed, and the water-glycol unit was filled on July 6. ECS servicing was completed on July 7 in an elapsed time of 121 minutes (including 40 minutes of hold time). The first integrated system test at the Florida facility with boilerplate 15 was successfully performed on July 9. Three relatively minor problem areas were encountered. Two amplifiers in the recorder console were inoperative and were replaced. Two fuses in the power control box were blown while on internal power, when the ECS fan and pump were turned on; these were replaced with 10-ampere fuses. (During boilerplate 13 operations, it had been determined that 5-ampere fuses were inadequate; they were replaced with 10-ampere fuses.) Boilerplate 15 fuses were temporarily replaced with 10-ampere fuses awaiting permanent NASA engineering order change. Two strain gauge amplifiers were found to be unbalanced; balancing is scheduled for completion on July 17.

In response to NASA request that a controlled environment be maintained around the command module, an environmental tent cover was fabricated and installed over the command module on July 13. The command module hatch cover and the environmental tent cover installations are as shown in Figures 7 and 8.

The LES motors were moved to the Merritt Island launch area on June 21; grain inspection of the LES motors was accomplished on June 24. Completion of LES buildup is expected by July 22.

Launch checkout and test operations with boilerplate 15 will be continued at pad 37B toward the conclusion of field operations on or about

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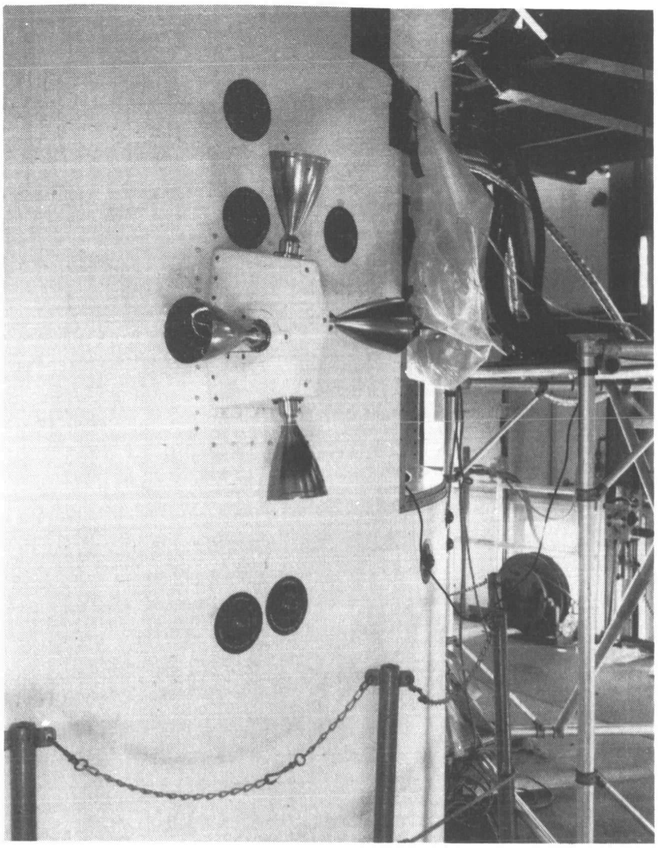

Figure 6. Installation of Instrumented Reaction Control Subsystem Engine Quad "A"

Figure 7. Command Module Hatch Cover

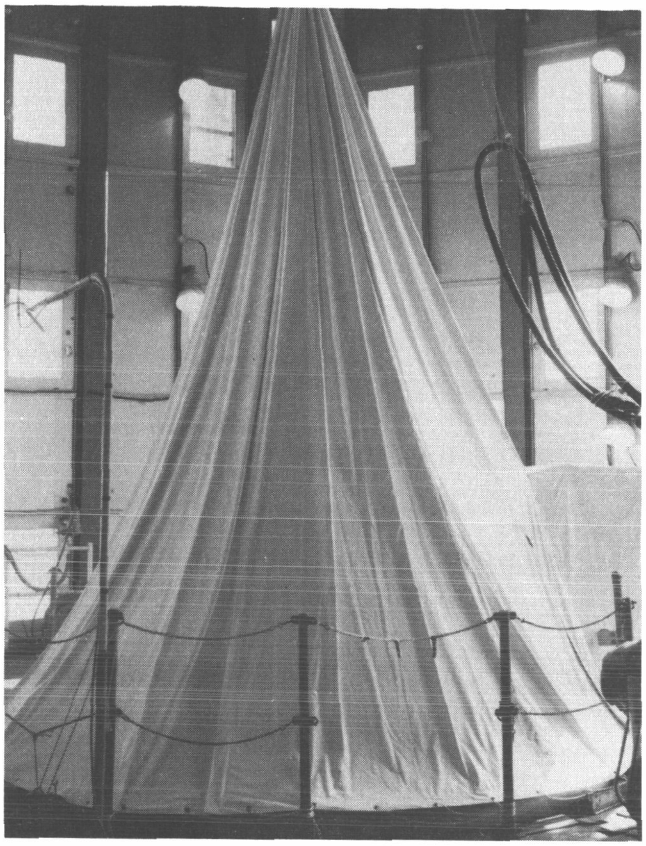

Figure 8. Command Module Environmental Tent

September 15. Spacecraft and launch vehicle electrical interface checks are to be completed on August 7. The launch vehicle sequence malfunction check is to be accomplished on August 12. Checkout preparations for boilerplates 16 and 26 are continuing within the scope of NASA redirection. Participation by S&ID in field checkout and test operations is essentially limited to mechanical mating, buildup and checkout of the LES, and mating the spacecraft and LES at pad 37B. The Operations Plan for boilerplates 16 and 26, to be completed by July 31, will outline in detail the S&ID effort in the field.

TEST PROGRAM SUPPORT

S&ID research pilots participated in an acoustic study conducted in the S&ID quality engineering laboratory. The study was conducted to determine the acoustic level at which the audible warning tone of the Apollo caution and warning system could be detected by a suited pilot while in the presence of a high (133-decibel) ambient noise level similar to a boost environment. With helmet attenuation of the ambient noise level to 110 decibels, it was possible to detect consistently the audible warning tone used during this study at the 85- to 90-decibel range.

The gust investigation phase of the Entry 2 simulation was completed. Two S&ID research pilots participated in this investigation, with each pilot accomplishing 30 data runs plus a number of training and experimental runs. Data from these runs are being evaluated.

The training portion of the failure effects analysis phase of the Entry 2 simulation was completed, and production runs were initiated. Each simulation began prior to the "0.05-g point" and was continued to drogue chute deployment at 25,000 feet altitude. One of the more critical failures investigated involved a divergence in vehicle attitude prior to attaining a dynamic pressure level where aerodynamic stability holds the vehicle in pitch and yaw trim. Failures must be detected and corrective control must be applied promptly, because the cross-coupling effects of the reaction control subsystem make it difficult to regain control and reorient the vehicle to the correct entry attitude in the limited time available. The three-axis attitude ball is most valuable in counteracting these failures.

Pilot participation in the Entry 2 simulation study and the failure effects analysis phase will be completed during the next report period.

Engineering evaluator 2 is being configured for Coast and Maneuver Study 2. It is expected that manned runs will begin during the next report period. Two research pilots will participate in this study to examine manual maneuver modes during midcourse phases of lunar missions and earth orbit mission phases.

FACILITIES

DOWNEY

Apollo Mock-Up Display and Design Engineering Inspection Area

The contract for the construction of the north and west walls (Phase I) for the mock-up DEI area has been awarded. The contractor began construction during the report period.

Subassembly Tube Brazing and Welding Facility

The 9800-square-foot clean room in building 6 has been completed. This room is to be used for brazing and welding of tubing subassemblies which must be performed in a dust controlled environment. Manufacturing equipment is currently being installed.

Acceptance Checkout Equipment (ACE) Installation

The first ACE system for the computer room, control room, and terminal facility room has been totally completed; it is currently undergoing checkout by supplier and S&ID personnel. This includes all the equipment necessary for the operational readiness of this ACE station.

The final layouts for the 90-foot extension to building 290 have been completed and signed off. This building extension is currently in architectural and engineering design. The facility construction is planned for completion in June 1965.

MIT Laboratory

The equipment for the first guidance and navigation checkout station has been installed in building 6, and the MIT laboratory area is now operational.

Grumman Tour

Grumman Aircraft facilities representatives attended a briefing and tour of environmentally controlled areas, conducted by Apollo facilities personnel. Grumman is interested in techniques employed to comply with environmental specifications. Various Apollo clean environment facilities were reviewed, including tube cleaning, the service module test cell, and clean rooms.

APPENDIX

S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS

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S&ID Schedule of Apollo Meetings and Trips
June 16 to July 15, 1964

Subject	Location	Date	S&ID Representatives	Organization
Technical aspects design review	Phoenix, Arizona	June 16	Abrahamson	S&ID, Cannon
SPS ablative chamber, discussion	Sacramento, California	June 16	Chen, Wolfelt	S&ID, Aerojet
Test results, observation	Goleta, California	June 16	Stone, Jones, Richardson	S&ID, General Motors
Contractual requirements and delivery, negotiation	Huntington, L.I., New York	June 16 to 18	Raggett, Cypert, Petak	S&ID, F.B. MacLaren
Boost trajectory data, meeting	Huntsville, Alabama	June 16 to 18	Pearce	S&ID, NASA
Engineering design review meeting	Minneapolis, Minnesota	June 16 to 18	Wright, Behrens, Wallace	S&ID, Control Data
Termination inventory review	Woodside, New York	June 16 to 18	Hansen, Schneider, Treman	S&ID, Avien
Over-all program discussion	East Alton, Illinois	June 16 to 19	Remick, Daoussis, Miller	S&ID, Olin-Mathieson
Block-II mock-up design determination	Moorestown, New Jersey	June 16 to 19	Womack	S&ID, RCA
Digital test command system design, briefing	Minneapolis, Minnesota	June 16 to 19	Wallace, Wright, Behrens	S&ID, Control Data
Zero-gravity flight test, participation	Dayton, Ohio	June 16 to 26	Armstrong	S&ID, NASA
Mode of operations	Bethpage, L.I., New York	June 17 to 19	Altenbernd, Garing, Gebhart	S&ID, Grumman
Flight table, final assembly and checkout	Shawnee, Oklahoma	June 17 to 18	Rovelsky, Sorensen	S&ID, Shawnee
Block I vehicle checkout flow, meeting	Cocoa Beach, Florida	June 17 to 20	Johnson	S&ID, NASA
Revised program, review	Sacramento, California	June 17 to 20	Cadwell	S&ID, Aerojet
Thermal interface meeting	Bethpage, L.I., New York	June 17 to 21	Koe, Stoll, Foiner	S&ID, Grumman
Acceptance testing, participation	Scottsdale, Arizona	June 17 to 19	D'Ausilio, Balodis, Maag	S&ID, Motorola
Apollo injector status review	Sacramento, California	June 18 to 19	Field	S&ID, Aerojet
Engineering cost reduction items, review	Minneapolis, Minnesota	June 18 to 23	Antletz	S&ID, Honeywell

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S&ID Schedule of Apollo Meetings and Trips
June 16 to July 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Boilerplate 15 receiving inspection	Cocoa Beach, Florida	June 18 to 26	Powers	S&ID, NASA
Heat shield and instrumentation, compatibility evaluation	Mountain View, California	June 19	Monda	S&ID, NASA
High-gain antenna, technical conference	Houston, Texas	June 21 to 22	McCabe, Ross	S&ID, NASA
S-band bench maintenance equipment, acceptance tests	Cedar Rapids, Iowa	June 21 to 24	Crabtree	S&ID, Collins
Apollo premodulation processor, acceptance tests	Cedar Rapids, Iowa	June 21 to 26	White	S&ID, Collins
Computer programming training activities, participation	Minneapolis, Minnesota	June 21 to July 2	Marzolf	S&ID, Computer Data
Downey facilities design review	Houston, Texas	June 22	Malysz	S&ID, NASA
Integrated guidance and control system, meeting	Houston, Texas	June 22 to 23	Zeitlin	S&ID, NASA
Food contract coordination meeting	Menlo Park, California	June 22 to 23	Osborne	S&ID, Stanford Research Institute
Single-point flotation study coordination	Houston, Texas	June 22 to 23	Roberts	S&ID, NASA
Selective freezing radiator, presentation	Houston, Texas	June 22 to 23	Jay, Laubach	S&ID, NASA
Program funding reduction, coordination	Binghamton, New York	June 22 to 23	Hatchell, Carter	S&ID, General Precision
Engineering assistance for Aerojet	Sacramento, California	June 22 to 24	Fow	S&ID, Aerojet
Implementing instrumentation of R&D measurements, discussion	Houston, Texas	June 22 to 24	Boothe, Stearns	S&ID, NASA
Project engineering coordination	Sacramento, California	June 22 to 26	Mower	S&ID, Aerojet
Working level meeting and modifications, discussion	Windsor Locks, Connecticut	June 22 to 24	Dziedziula, Haky, Zelon	S&ID, Hamilton Standard
Boilerplate 22 breadboard checkout support	Houston, Texas	June 22 to July 2	Chavez	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
June 16 to July 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Engineering coordination meeting	Cedar Rapids, Iowa	June 23 to 25	Murufas, Chapin	S&ID, Collins
Cost reduction action items, discussion and implementation	Buffalo, New York	June 23 to 25	Gibb, Wagner, Hawken	S&ID, Bell
Program review meeting	Rolling Meadows, Illinois	June 23 to 26	Greenfield	S&ID, Elgin
Engineering coordination	Sacramento, California	June 23 to 26	Fow, Davidson	S&ID, Aerojet
Subpanel and communications and instrumentation panel, meeting	Huntsville, Alabama	June 23 to 26	Chambers	S&ID, NASA
Technical interchange meeting	Lowell, Massachusetts	June 24 to 26	Wagner	S&ID, Avco
Checkout panel meeting	Houston, Texas	June 24 to 26	McMullin, Egan, Gebhart	S&ID, NASA
Engineering coordination	Scottsdale, Arizona	June 24 to 26	Hall, Tyner	S&ID, Motorola
Hardware completion, status review	Sacramento, California	June 24 to 26	Cadwell	S&ID, Aerojet
Contract negotiations, participation	Sacramento, California	June 24 to 26	Colston	S&ID, Aerojet
Module acceptance test procedures	Cedar Rapids, Iowa	June 24 to 27	Himmelberg	S&ID, Collins
Instrumentation interface areas, discussion	Bethpage, L.I., New York	June 24 to 27	Zemenick	S&ID, Grumman
Monthly technical interchange meeting	Lowell, Massachusetts	June 24 to 26	Howard, Statham, Confer	S&ID, Avco
Cost reduction activities, implementation	Sacramento, California	June 25 to 26	Field	S&ID, Aerojet
Supplemental changes, negotiation	Buffalo, New York	June 25 to July 2	Frankhouse	S&ID, Bell
Technical and program status review	Trevose, Pennsylvania	June 28 to 30	Anderson, Saindon, Bradanini, Brown	S&ID, United Aircraft
Qualification test procedures, discussion	Boston, Massachusetts	June 28 to 30	Moen	S&ID, Space Science
Boilerplate 22 configuration and test point meeting	Houston, Texas	June 29 to 30	Helms, Gillies	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
June 16 to July 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Production, scheduling and manufacturing surveillance	White Sands, New Mexico	June 29 to 30	Field, Gallanes	S&ID, NASA
Environment control section meeting	Houston, Texas	June 29 to 30	Woody	S&ID, NASA
Engineering change coordination; current fabrication problems, discussion	Middletown, Ohio	June 29 to July 2	Stover, Confer, Flournoy	S&ID, Aeronca
Crew safety system, meeting	Clear Lake, Texas	June 29 to July 1	Vucelic, Pearce	S&ID, NASA
Functional requirements, definition	Boston, Massachusetts	June 29 to July 1	Damm	S&ID, MIT
Acceptance test procedures	Hightstown, New Jersey	June 29 to July 1	Kolb, Gigante, Backman	S&ID, RCA
Interface control documentation, meeting	Clear Lake, Texas	June 29 to July 1	Neatherlin, Creek	S&ID, NASA
Block II electronic packaging, meeting	Cedar Rapids, Iowa	June 28 to July 2	Fleck	S&ID, Collins
Premodulation processor electromagnetic compatibility, meeting	Cedar Rapids, Iowa	June 29 to July 2	Traver	S&ID, Collins
Engineering coordination	Minneapolis, Minnesota	June 29 to July 2	Notti, Murphy, Jandrasi, Ferentz	S&ID, Honeywell
Electrical systems integration panel meeting	Houston, Texas	June 29 to July 2	Crawford	S&ID, NASA
Technical progress evaluation	Sacramento, California	June 29 to July 2	Mower	S&ID, Aerojet
Design review meeting	Cedar Rapids, Iowa	June 29 to July 2	White	S&ID, Collins
Subcontractor quotations, negotiation	Middletown, Ohio	June 29 to July 2	Stover, Confer, Flournoy, Harrison	S&ID, Aeronca
Dynamic motion simulator, acceptance testing	Shawnee, Oklahoma	June 29 to July 2	Hughes, Salaya	S&ID, Shawnee
Parachute drop tests, monitoring and observation	El Centro, California	June 29 to July 26	Close	S&ID, NASA
Tankage system Phase II testing, representation	Tullahoma, Tennessee	June 29 to August 17	Palmer	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
June 16 to July 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Engineering coordination	Santa Clara, California	June 30	Lee	S&ID, Explosive Technology
Command-service module, discussion	Bethpage, L.I., New York	June 30 to July 2	Damm	S&ID, Grumman
Mechanical integration subpanel meeting	Huntsville, Alabama	June 30 to July 2	Tooley	S&ID, NASA
Current technical status, meeting	Houston, Texas	June 30 to July 1	Eberle	S&ID, NASA
Engineering coordination meeting	Cocoa Beach, Florida	July 5 to 10	Johnson	S&ID, NASA
Propulsion systems management committee meeting	Sacramento, California	July 5 to 6	Carlson	S&ID, Aerojet
Coordination meeting	Cocoa Beach, Florida	July 5 to 9	Gardner	S&ID, NASA
Supplier's design progress review	Sunnyvale, California	July 6 to 7	Walker, Barmore, Farr, Temoyan	S&ID, Thermatest
Program review	Houston, Texas	July 6 to 7	Osbon	S&ID, NASA
Block II integrated guidance and control coordination meeting	Houston, Texas	July 6 to 8	Walli, Levine, Knobbe	S&ID, NASA
Ordnance system problems, meeting	Houston, Texas	July 6 to 8	Sweet, Necker	S&ID, NASA
Interleaver interface coordination meeting	Melbourne, Florida	July 6 to 9	Whitehead	S&ID, Radiation
Engineering technical liaison	Las Cruces, New Mexico	July 6 to 9	Roberts	S&ID, NASA
Central timing equipment program and design review	Rolling Meadows, Illinois	July 6 to 9	Covington, Cason, Forrette, Schiavi	S&ID, Elgin
Acceptance test procedure, observation	Scottsdale, Arizona	July 6 to 10	Bickerstaff	S&ID, Motorola
Engineering coordination	Scottsdale, Arizona	July 6 to 10	Skelton	S&ID, Motorola
NASA-industry welding symposium	Huntsville, Alabama	July 6 to 10	Collipriest	S&ID, NASA
Project engineering coordination	Sacramento, California	July 6 to 10	Mower	S&ID, Aerojet
General humidity problems, discussion	Minneapolis, Minnesota	July 6 to 11	Radeke	S&ID, Honeywell
Project engineering coordination	Cocoa Beach, Florida	July 6 to 25	Condit	S&ID, NASA
Test data and procedures, review	Buffalo, New York	July 6 to 29	Burge	S&ID, Bell

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S&ID Schedule of Apollo Meetings and Trips
June 16 to July 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Phasing and technical problems, discussion	Lima, Ohio	July 7 to 8	McCarthy	S&ID, Westinghouse
Thermal interface engineering coordination meeting	Cambridge, Massachusetts	July 8 to 12	Percy, Copeland	S&ID, MIT
Wind tunnel test support	Tullahoma, Tennessee	July 8 to 10	Eder	S&ID, NASA
Quarterly review and negotiation	Houston, Texas	July 8 to 10	Webb	S&ID, NASA
Dynamic motion simulator program status review	College Point, New York	July 8 to 10	Raggett, Sorensen	S&ID, Vogue
Launch escape motor inspection, coordination	Las Cruces, New Mexico	July 8 to 10	Spencer	S&ID, NASA
Flight qualification instrumentation breadboard concept, presentation	Houston, Texas	July 9 to 10	Beacon	S&ID, NASA
Abort trajectory study analysis	Houston, Texas	July 9 to 10	Raymes, Meston	S&ID, NASA
Mission definitions, discussion	Binghamton, New York	July 12 to 19	Frimtzis, Flatto	S&ID, Grumman
Fuel gauging system fabrication problems, evaluation	Burlington, Vermont	July 12 to 23	Bratfisch	S&ID, Simmonds
Instrumentation systems design coordination	Houston, Texas	July 12 to 25	Chaves	S&ID, NASA
Acceptance test procedure, observation	Cedar Rapids, Iowa	July 12 to 24	Moreau	S&ID, Collins
Technical progress monitoring and evaluation	Sacramento, California	July 13 to 17	Mower	S&ID, Aerojet
Hardware program review	Burlington, Massachusetts	July 13 to 17	Damm, Goldman	S&ID, RCA
Guidance control analysis coordination	Houston, Texas	July 14 to 17	Barnett	S&ID, NASA
Program review meeting	Sacramento, California	July 14 to 16	Field	S&ID, Aerojet
Task group meeting	Binghamton, New York	July 14 to 16	Kitakis	S&ID, General Precision

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S&ID Schedule of Apollo Meetings and Trips
June 16 to July 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
EPS subsystem management meeting	Houston, Texas	July 14 to 16	Templeton, Nash	S&ID, NASA
Docking simulation study	Houston, Texas	July 14 to 15	Armstrong	S&ID, NASA
TV camera program technical and cost aspects, presentation	Houston, Texas	July 15 to 17	Doll	S&ID, NASA
Passive thermal control discussion	Houston, Texas	July 15 to 16	Barnett, Mielak	S&ID, NASA